ESRI International User Conference
July 13–16, 2010 | San Diego, CA

Technical Workshops

Managing Imagery and Raster Data in ArcGIS

Hong Xu, Sangeet Mathew, Mark Harris

esri

Presentation Overview

- ArcGIS raster data models
- Which model to use
- Mosaic dataset storage and properties
- Build a mosaic dataset
- Migrate to mosaic datasets

- Q&A

Please fill out the evaluation forms before you leave the session

Imagery Management Challenges

- Many sources
  - Aerial photographs
  - Satellite imagery from many sensors
  - DEM and scanned maps
  - Analytical data, pictures
- High resolution and large volume

- Requirements:
  - Store efficiently
  - Easy to search
  - Fast to process
  - Accessible

Evolution of Raster Data Models in ArcGIS

- **Raster dataset (8.0)**
  - A single image
- **Raster catalog (9.0)**
  - A collection of raster datasets
  - Members can be accessed
  - Managed/unmanaged
- **Raster attribute (9.0)**
  - A table or feature class field containing picture attributes
  - **Mosaic dataset (10.0)**
  - Enhanced raster catalog with mosaic view and on the fly processing capability
  - Managing and serving a collection of images

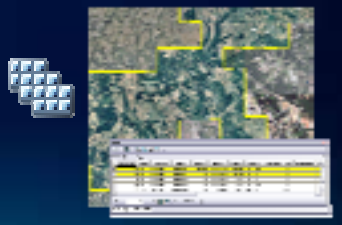


Image Management Recommendations in ArcGIS 10

- Manage individual images using raster datasets
- Manage image collections using new mosaic datasets
- Manage pictures/raster attributes using raster field in table or feature class

Image Management Recommendations in ArcGIS 10

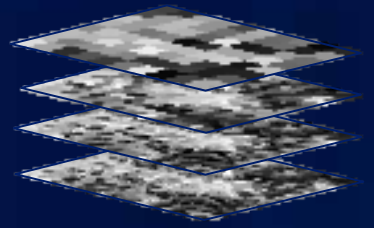
- Manage individual images using raster datasets
- Manage image collections using mosaic datasets
- Manage pictures/raster attributes using raster field in table or feature class
  - Adding raster datasets as attributes in a feature class

Raster Datasets - Formats

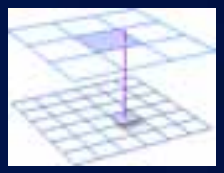
- Many file formats
  - TIFF, GRID, Mrsid, JP2000, JPEG, NITF, CADRG, etc
  - Geodatabses
- Improved the raster format support
  - Support for BigTIFF in ArcGIS 10 (new)
  - Compressed TIFF with LZW/JPEG/PackBits/CCITT/RLE (new)
- Support for custom raster formats (improved)
  - Resources.arcgis.com image management code gallery

Raster Datasets - Properties

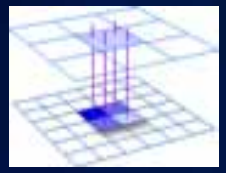
- **Pyramids**
  - Reduced resolution copies of the source
  - Improve display performance
  - Support three resample methods
  - Can be compressed (new)
  - set in GeoProcessing environment



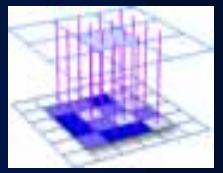
Factor of 2



Nearest neighbor



Bilinear interpolation



Cubic convolution

- **Statistics**
  - Enhance visual display

Unstretched:
Min: 24
Max: 241

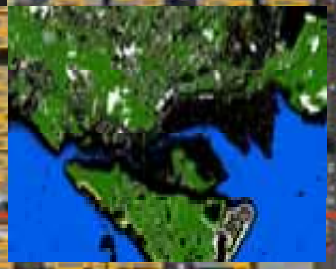
Stretched:
Min: 0
Max: 255

- **Build Pyramids and Statistics tool (new)**

Raster Datasets – Recommendations

- Use it “as is”
  - Especially for compressed formats
- Better performance
  - Convert to tiled TIFF using the CopyRaster tool
  - JPEG compressed TIFF if lossy compression is allowed
  - File Geodatabase raster dataset is also a comparable format

Demo: Raster Data Models



Raster datasets

Raster catalogs

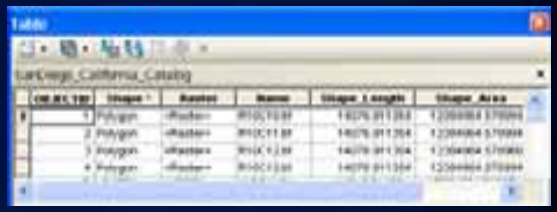
Mosaic datasets

Managing Imagery Collections

- **Solution in 9.3 is raster catalog**
  - image service definition
- **Solution in 10 is mosaic dataset**

Raster Catalogs

- A data model for managing a collection of images in 9.3
  - Stores footprints and rasters in a table
  - Managed/unmanaged
- Uses
  - Catalog images and maintain overlaps
  - Search based on attributes and location
  - Access selected members
  - Display footprint/pixel view
- Limitations
  - Do not support sensor data and metadata
  - No overview
  - Can't be served by ArcGIS server



ArcGIS Image Server

- A way of serving a collection of images in 9.3
  - Image service definition
  - Shape file to store footprints
  - Reference images on disk
- Uses
  - Serve a seamless image mosaic
  - On-the-fly mosaicking and image processing
  - Sensor data and metadata data
- Limitations
  - Limit to 2 million records
  - Does not support LINIX
  - Have to manage two servers
  - Different customization pattern

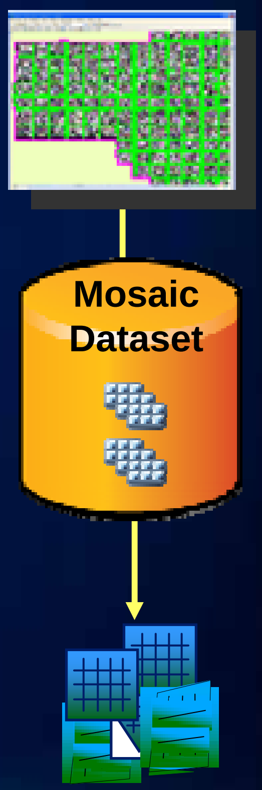
Mosaic Datasets - New Geodatabase Data Model

- Manage and serve collection of images
  - Supported in SDE/FGDB/PGDB
  - Does not load source pixels into geodatabase, instead references imagery

- Manage data with an internal raster catalog

- Displays like a raster dataset

- On-the-fly image processing



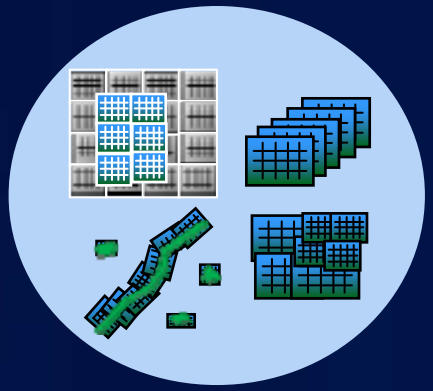
Mosaic Datasets - Advantages

Processing Time
Reduces processing

Storage
Eliminates redundancy

Scalable
Catalog large image collections

Seamless Display
at all scales



Sensor support
Support multiple sensors

Metadata
Maintains valuable information

Preserves information
Overlapping Imagery

Disparate Datasets
Manages large NoData areas

Maintenance
Streamlines image updates

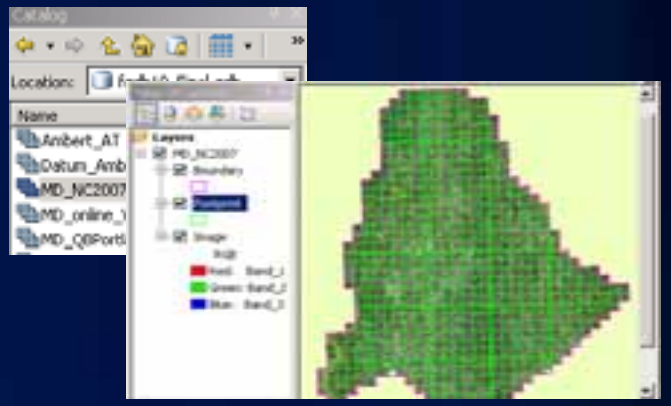
Image Quality
Reduces resampling

Data Management Recommendations

- Use your existing data model if they continue to meet your existing application requirements
- Use the mosaic dataset for new applications
- Migrate to the mosaic dataset to take advantages of its new features

Mosaic Dataset – Usage

- A composite layer of
  - Boundary/Footprint/Image
- Use as a catalog
  - Search images
  - View metadata
  - Add selected images to Map
  - Time aware
- Use as a raster dataset
  - Display like a raster layer
  - Export a raster dataset
  - Use as an input to geoprocessing tool
- Serve as an image service



	OBJ	Raster	Name	Min	Max	Low	HighPS	Category
▶	1	<Raster>	op2008_59515_N	0	6	1	2	Primary
	2	<Raster>	op2008_59516_N	0	6			
	3	<Raster>	op2008_59517_N	0	6			
	4	<Raster>	op2008_59518_N	0	6			
	5	<Raster>	op2008_59519_N	0	6			

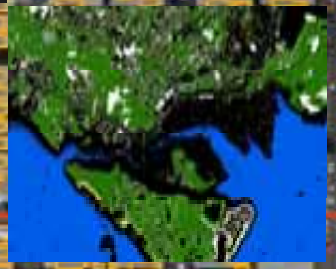
Mosaic Dataset – Mosaic Rules

- Control which raster/pixels to display
- Mosaic method to sort the rasters
  - Closest to center (default)
  - By attribute
  - Closest to nadir
  - North west
  - Seamline
- Mosaic operator to resolve the overlaps
  - First/Min/Max/Mean/Blend

Closest to the center

By attribute: cloud cover

Demo: Using Mosaic Datasets



Mosaic Dataset Storage Schema

- **Stored as a set of internal geodatabase tables**
- **Some can be modified through user interface**
  - **DO NOT modify using database SQL statements**

Name	Purpose	Viewable
Catalog	A raster catalog that stores function rasters and the footprints	Yes
Boundary	A feature class that defines the mosaic dataset boundary	Yes
Seamline	A feature class that maintains the seamlines for advanced mosaicking operations	Yes
Raster Type	A table holding each raster type instance	Yes
Log	A table that logs operations that have been performed	Yes
Overview	A table that stores references to the overview rasters	No
Cell size level	A feature class with cell size levels for overview generation	No
Stereo	A table that stores the stereo pair	No
Color correction	A table of derived rasters for color correction	No

Mosaic Dataset Storage – Catalog Table

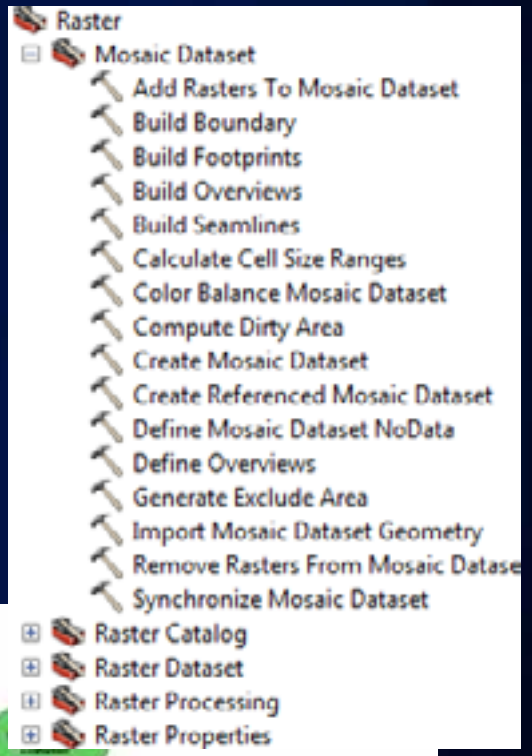
OID	Shape	Raster	Name	LowPS	HighPS	MinPS	MaxP	Category	…
1	Polygon	<Raster>	P01.met	10	30	0	90	Primary	
2	Polygon	<Raster>	P02.met	10	30	0	90	Primary	
5	Polygon	<Raster>	filename1.tif	90	90	90	270	Overviews	

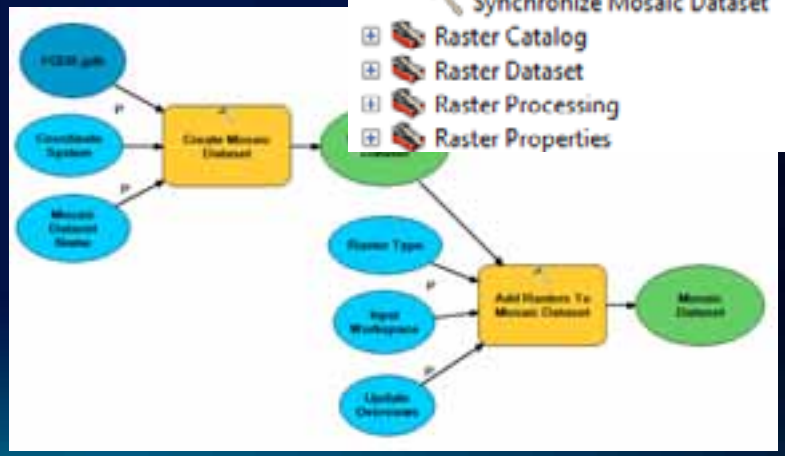
- A special raster catalog
  - Shape field stores the footprints
  - Raster field stores function raster datasets
- Function raster datasets
  - Contains functions and input of the functions
  - Defined by raster type and populated when rasters are added
- MinPS and MaxPS define the visible ranges of the rasters

Build a Mosaic Dataset

- Mosaic dataset toolset
- Automate with model and python

- Typical workflow
  - Create a mosaic dataset
  - Add rasters
    - Calculate cell size range
    - Build boundary
  - Build overviews (optional)
  - Edit properties (optional)



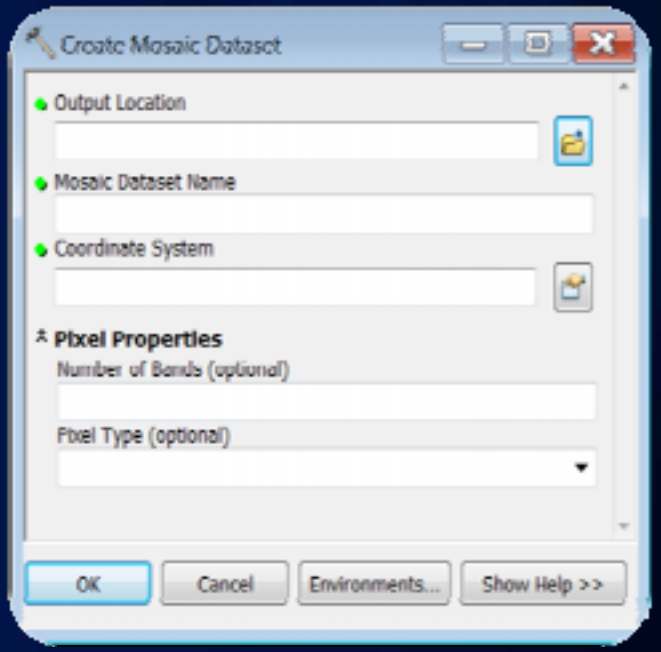


Build a Mosaic Dataset - Create

- Create table schema and define pixel properties

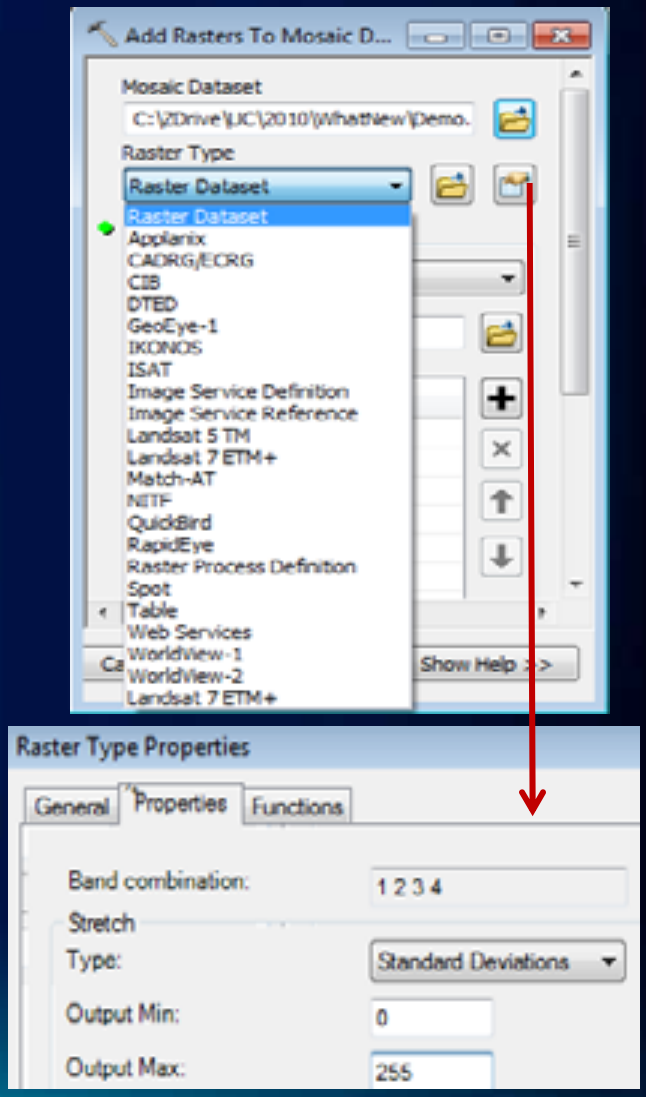
- Spatial reference (required)
  - Used in footprints and overviews
  - Define a proper one
  - Datum consideration

- Number of bands
  - Taken from the first added raster
- Pixel type
  - Taken from the first added raster



Build a Mosaic Dataset – Add Rasters

- Use Add Rasters to Mosaic Dataset tool
- Choose a raster type
  - Define the format to crawl
  - Metadata to read and fields to create
  - Processes to apply
- Support many raster types
  - Raster Dataset/NITF/CADRG/etc.
  - QB/IKONOS/GeoEYE/WoIrdView/etc
    - Working with Sensor Image Data in ArcGIS
  - Web Services
  - Table/Image Service Definition

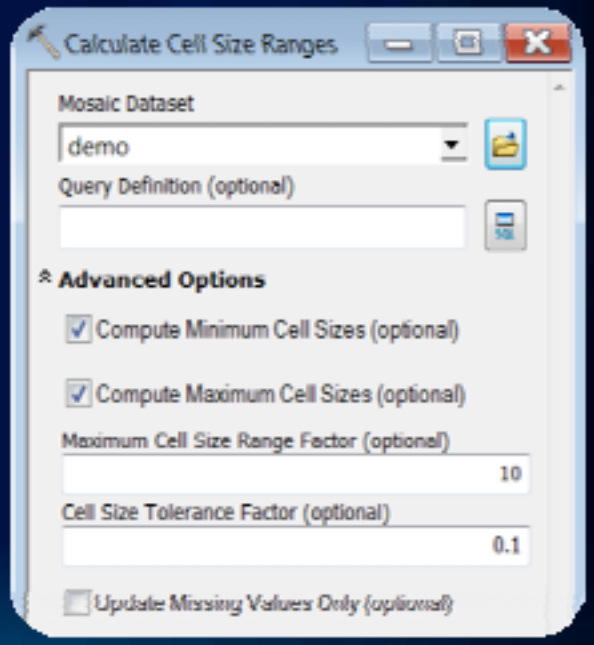


Build a Mosaic Dataset – Cell Size Ranges

OBJECTID *	Raster	Name	MinPS *	MaxPS *	LowPS *	HighPS *	Category	Tag
1	<Raster	Campus_08May2008	0	12.329262	0.616463	1.232926	1	Dataset
2	<Raster	Campus_14May2008	0	11.338233	0.566912	1.133823	1	Dataset

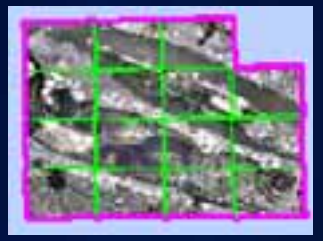
- MinPS and MaxPS define the visibility of the rasters
- Use Calculate Cell Size Ranges tool
- Based on source and overlaps
- Default cell size range factor is 10

30m visible range 0-300
5m visible range 0-50 → 5-30
1m visible range 0-5



Build a Mosaic Dataset - Boundary

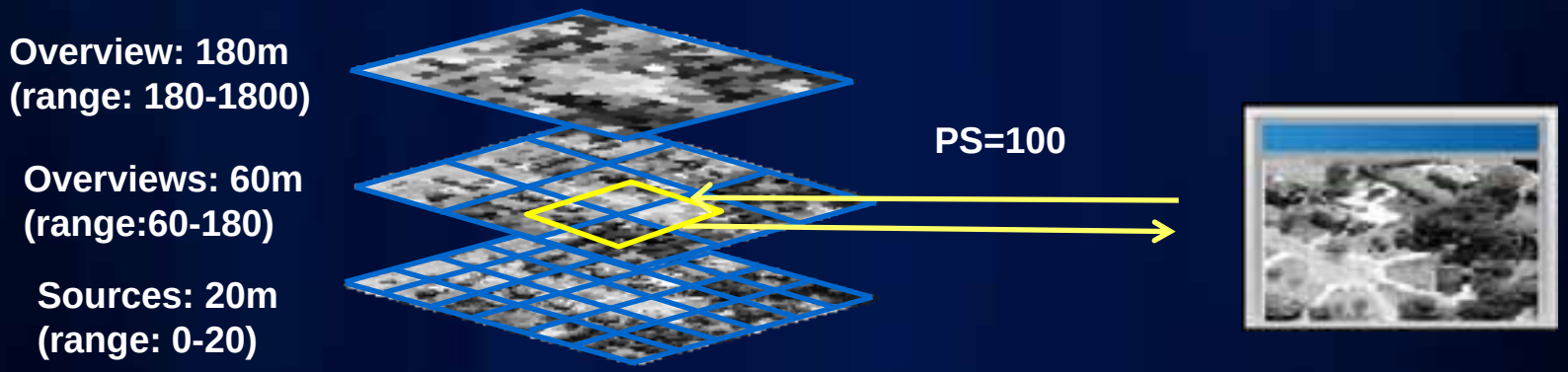
- Define the boundary of the mosaic dataset
  - Pixels outside the boundary will be clipped



- Build using Build Boundary tool
  - Calculated based on footprints
- Can be modified using Editor
- Import using Import Mosaic Dataset Geometry tool

Build a Mosaic Dataset – Overviews

- **Resampled rasters**
  - **Multiple levels**
  - **Multiple tiles for each level**
- **Seamless image display**



Build a Mosaic Dataset – Overviews (Cont…)

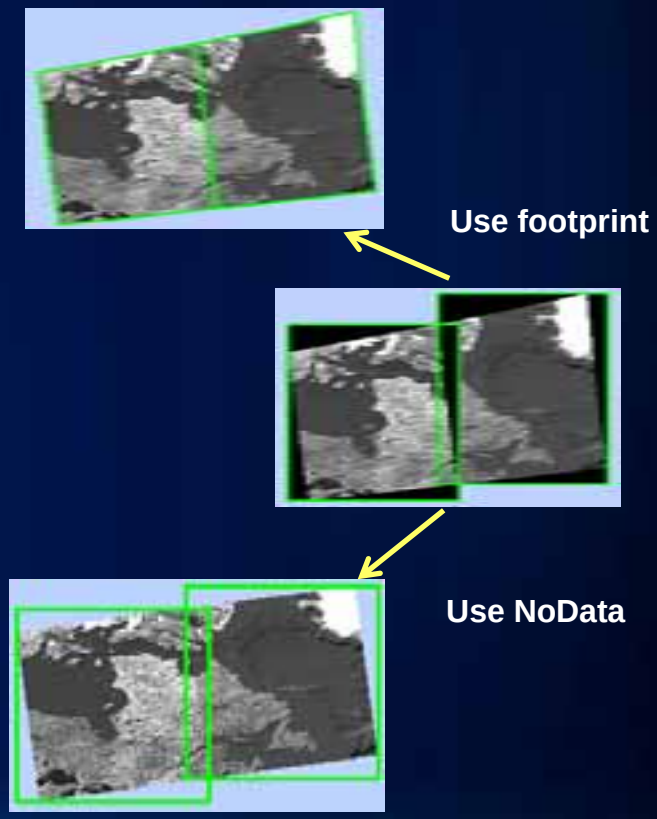
OID	Shape	Raster	Name	LowPS	HighPS	MinPS	MaxPS	Category	…
1	Polygon	<Raster>	P01.met	10	30	0	90	Primary	
2	Polygon	<Raster>	P02.met	10	30	0	90	Primary	
3	Polygon	<Raster>	filename1.tif	90	90	90	900	Overviews	
4	Polygon	<Raster>	filename2.tif	90	90	90	900	Overviews	

- **Build Overviews tool**
  - **Generate overview images**
- **Define Overviews tool**
  - **Redefine the default parameters**
- **Optionally add an external raster as overview**

Default overview parameters:
TIFF format with JPEG
Size is 5120x5120
Factor of 3
Overview location

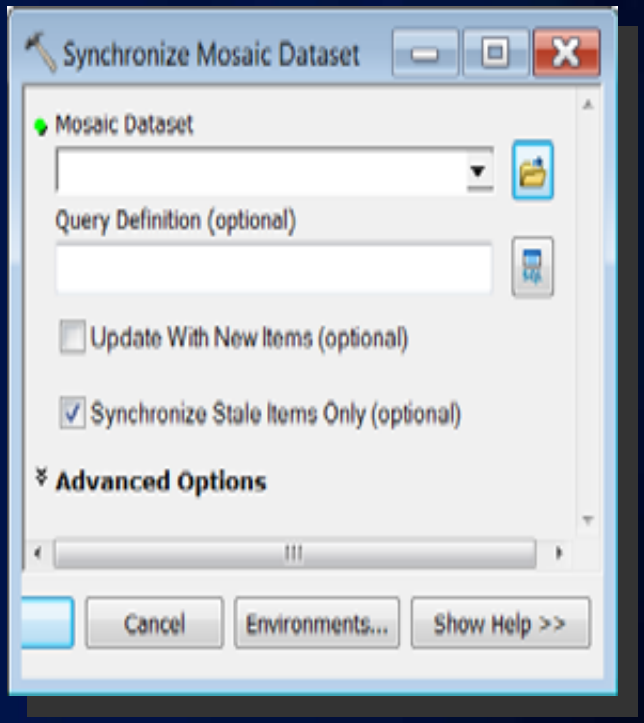
Building a Mosaic Dataset – Managing Background

- **Footprint**
  - **Build Footprint tool**
  - **Edit using Editor**
  - **Import using Import Mosaic Dataset Geometry tool**
- **Define NoData**
  - **Set NoData based on a value**
  - **Set NoData based on a range**

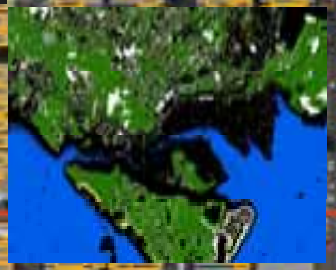


Building a Mosaic Dataset – Update

- Add new rasters
  - Use Add Raster tool
  - Use Synchronize Mosaic Dataset tool
- Remove Rasters
  - Use Remove Rasters from Mosaic Dataset tool
- Sources rasters are changed
  - Changes in geometric/metadata/etc.
  - Update with Synchronize Mosaic Dataset tool



Demo: Build Mosaic Datasets



Build a mosaic dataset

Automate using geoprocessing model

Mosaic Dataset – Advanced Mosaicking

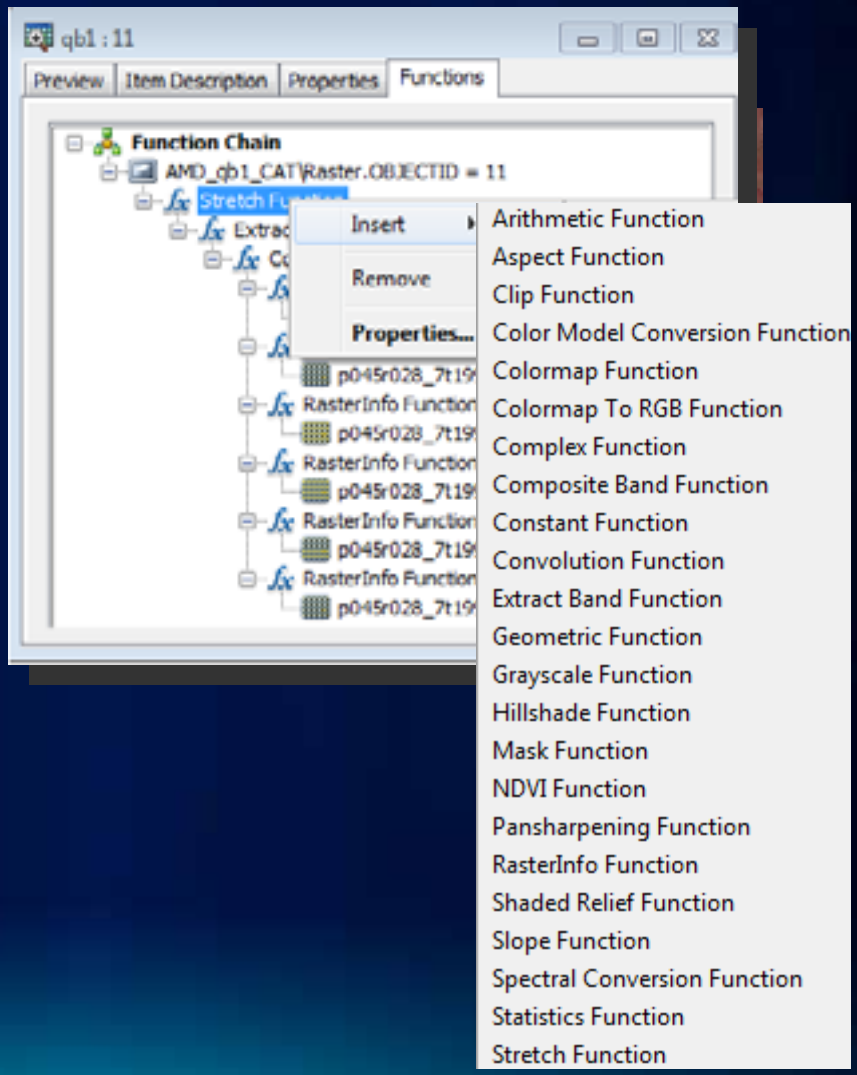
- Color correction
  - Balance to a color surface
  - Balance to an existing target
  - Support excluded area
  - Color Correction window
- Seamline
  - Build Seamline tool
  - Modify seamline using Editor
  - Import seamline feature class

Before

After

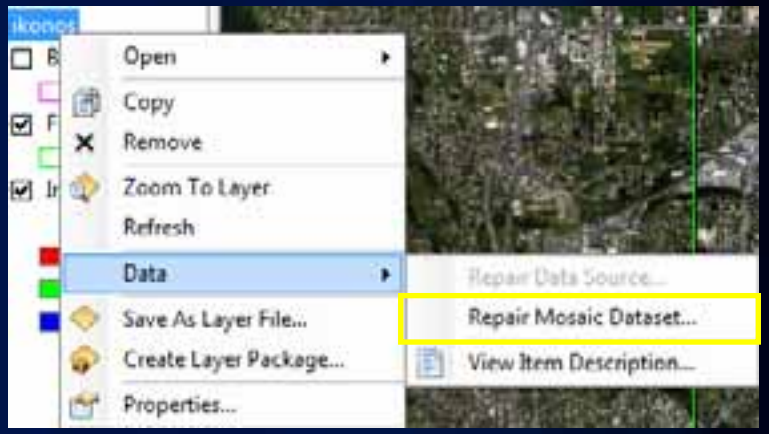
Mosaic Dataset – Editing Raster Functions

- **Process image on-the-fly**
  - Image enhancement
  - Orthorectification, Pan-sharpen
  - Shaded relief, hillshade, etc
- **Add at mosaic dataset level**
- **Add at raster level**
  - Apply to the raster

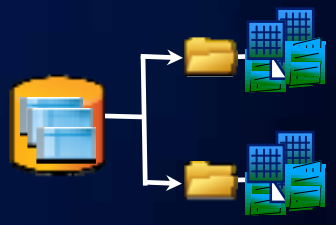


Moving a Mosaic Dataset

- **Move all**
  - Copy/paste the mosaic dataset
  - Copy the source and overview images
  - Use Repair dialog to repair the paths



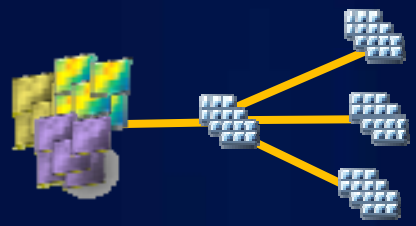
- **Extract a portion**
  - Create a target FGDB in a new folder
  - Use Distributed Geodatabase toolbar
  - Copy/move the whole folder
  - Mosaic dataset is ready
    - No need to run the Repair tool



Reference Mosaic Dataset

- References an external mosaic dataset or raster catalog
  - Supported in GDB and file (.amd)
  - Catalog table is not editable

- Created by specifying
  - Definition query
  - Area of interest



Boundary = My County

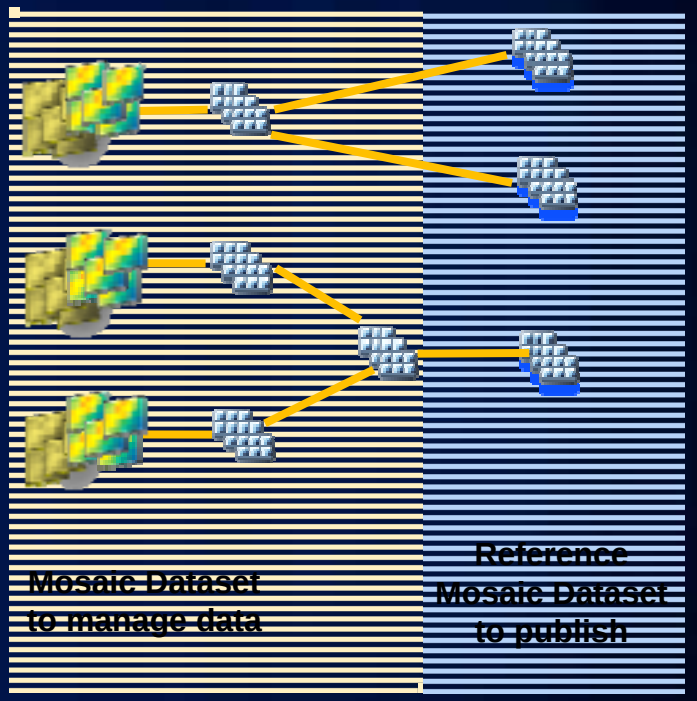
Where Sensor = Landsat and Cloud <10%

Add NDVI processing

- Provides multiple views of the source mosaic dataset
- Prevents editing of the source mosaic dataset

Image Management Patterns

- Create mosaic datasets with data of similar type
  - Elevation
  - Ortho images of same date
  - Imagery with similar sensor, number of bands, and bit depth
    - QuickBird/IKONOS
    - Landsat 5 or 7
- Create referenced mosaic datasets to publish



Publishing Raster Data

- Raster dataset and mosaic dataset can be published as image services
- Image services from the mosaic dataset
  - Can be accessed as an image and a catalog
  - Support selection and definition query
  - Downloading
  - Time aware
- Image services from raster datasets have only mosaic view

- For further information, attend the workshop:
  - Working with ArcGIS Server Image Services

Migrating to Mosaic Datasets

- From image service definitions

Image service Definitions	Mosaic dataset
.\Amberg.ISDef	
ImageService.ISDef	Mosaic dataset
Footprint.dbf	Footprint feature class
Boundary.dbf	Boundary feature class
Seamline.dbf	Seamline feature class
.\RPDefs\rasteris.RPDefs	Function raster datasets

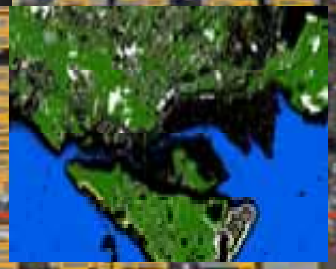
- Workflow
  - Create a mosaic dataset
  - use Image Service Definition raster type
  - Add the ISDef file
  - Raster Process Definition raster type

- From a raster catalog
  - Create a mosaic dataset
  - Use Table type to add
  - Raster datasets are re-added as function raster datasets

Licensing

- **Mosaic Dataset**
  - View: ArcView license
  - Create / edit: ArcInfo/ArcEditor license
  - Serve: ArcGIS server + Image extension license
- **Raster Dataset**
  - View: ArcView license
  - Create / edit: ArcInfo/ArcEditor license
  - Serve: ArcGIS server

Demo



Reference Mosaic Datasets

Migrating to Mosaic Datasets

Summary

- Use raster dataset to manage individual images
- Use mosaic dataset for image collections
  - Mosaic dataset schema
  - Mosaic dataset usage
  - Build a mosaic dataset
  - Migrate to mosaic datasets

Raster Product Sessions

Using Imagery and Raster Data

Tuesday 8:30 AM – 6D
Wednesday 1:30 PM - 6D

What's New in Imagery and Raster at ArcGIS 10

Wednesday 12:00 PM – 6D
Thursday 12:00 PM – 6D
Friday 9:00AM - 4

Managing Imagery and Raster Data

Tuesday 10:15 AM – 6D
Wednesday 3:15 PM – 6D

Working with Sensor Image Data

Tuesday 10:15 AM – 3
Thursday 3:30 PM – 3

Working with Image Services and ArcGIS Server

Wednesday 8:30 AM – 6D
Thursday 1:30PM – 6D

Building Web Applications for Image Services

Tuesday 11:00AM
Server Island

Georeferencing Raster Data

Tuesday 1:00 PM
GDB Island

Creating Mosaic Datasets

Wednesday 11:00 AM
GDB Island

Using the Image Analysis Window

Thursday 12:00 PM
GDB Island

Imagery @ UC 2010

	Omni Ballroom A/B	Exhibit Hall and Demo Theaters
Tuesday	Imagery Plenary Keynote speakers Imagery Highlights Case Studies	GeoEye PCI Geomatics Ricoh ESRI Canada
Wednesday	Moderated Paper Sessions Industry Panel Discussions Special Interest Group Meeting Imagery Social (Ballroom C)	Valtus Earthmine i-cubed ITT VIS

Evaluations

Please fill out the evaluation forms…

Your comments help us meet your conference needs each year.

THANK YOU VERY MUCH FOR ATTENDING !

Questions?

Additional resources:

- Desktop/Online Help
- Imagery section at resources.arcgis.com
- Image Blog http://blogs.esri.com/Dev/blogs/imagery/default.aspx